THE JOURNAL OF

THE INSTITUTION OF PRODUCTION ENGINEERS

Vol. 31, No. 8, August 1952

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Two lines of
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Capstan Lathes producing a wide range of motor accessory components at
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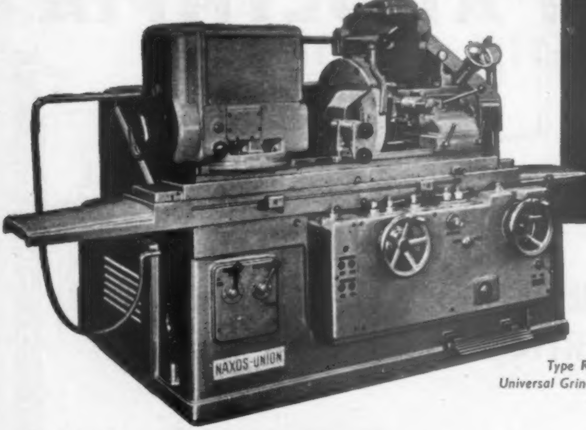
R300 TYPE



Type RU300
Universal Grinding Machine

six machines deve

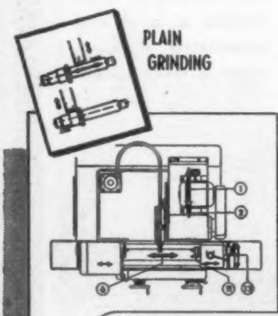
The R
meet
In add
of m

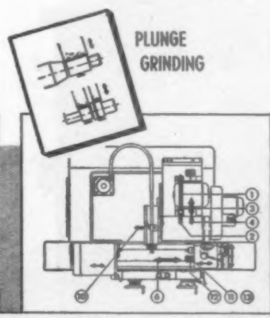
RG300 Plain Grinder. The basic machine of the series, fitted with hand feed only to wheel-head and work-table. Provided with a fine feed and fast table traverse (five times), the machine is particularly suitable for small batch work of simple character.

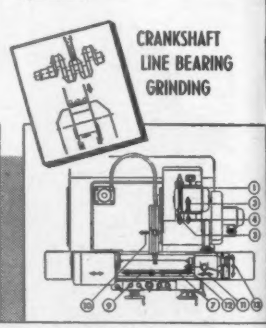
RE300 Plunge Grinding Machine. Employs wide or multiple wheels. Hydraulic movement to grinding head with fast approach, fine feed, and fast return. Dual control axial adjustment for grinding to shoulders. Hand table traverse (two speeds). Fine diameter control. Hydraulic tailstock withdrawal.

RM300 Crankshaft Line Bearin Grinding Machine. Similar in design t Type RE300, but arranged to carry thinner but larger grinding whee Hydraulic table movement for quic indexing from bearing to bearing Interlocked controls obviate incorrec operation.

RP300 G Machine. movement table trav For grin traversing plunge-cu cally oper







BLACK ARROWS Automatic hydraulic movement.
OPEN ARROWS Hand adjustment.
THIN ARROWS Possibility of adjustment.

1. Hand movement of the grinding spindle head.
2. Fine adjustment by hand.
3. Hydraulic quick adjustment of the grinding spindle head.
4. Hydraulic plunge-cut motion.
5. Automatic fine adjustment during longitudinal grinding.
6. Table hand movement, one speed.
7. Tab
8. Hyd rev
9. Hyd

WICKMAN *of* COVENTRY

LON
LEED

NAXOS UNION

CYLINDRICAL GRINDING MACHINES

developed from one basic type, and unit built

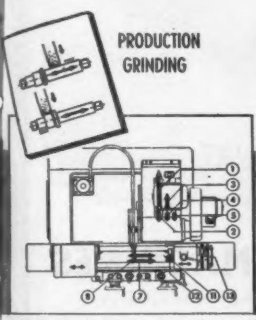
The R300 series of standard machines, utilising various unit mechanisms in combination, meet a wide variety of production grinding applications in the most economical manner. In addition to these standard types, machines can be supplied with different combinations of mechanisms to meet special conditions.

RP300 General Purpose Grinding Machine. Hydraulic grinding head movement and automatic hydraulic table traverse with automatic reversal. For grinding long workpieces with traversing table, and for automatic plunge-cut grinding. Tailstock hydraulically operated.

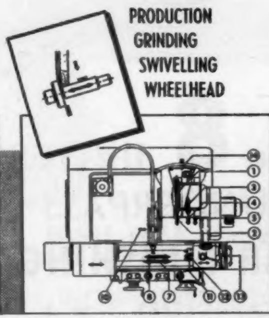
RS300 General Purpose Machine with Swivelling Grinding Head. Similar to RP300, fitted in addition with a swivelling grinding head with axial adjustment. Suitable for plunge grinding short length tapers and tangent grinding the sides of collars or faces.

RU300 Universal Grinding Machine. In addition to the features of the basic type this model has automatic longitudinal movement of the table, swivelling wheel-head and work-head, and internal grinding attachment. Suitable for all grinding work on cylindrical or tapered components of toolroom character.

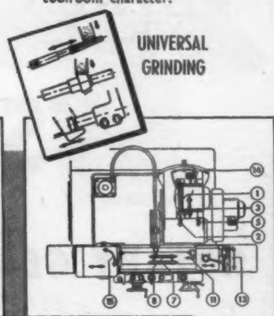
PRODUCTION GRINDING



PRODUCTION GRINDING SWIVELLING WHEELHEAD



UNIVERSAL GRINDING



7. Table hand movement, two speeds.
8. Hydraulic table movement with reversal.
9. Hydraulic fast motion of the table.
10. Axial movement of the grinding spindle.
11. Return motion of the tailstock spindle sleeve by hand.
12. Hydraulic return motion of tailstock spindle sleeve.
13. Table can be swivelled.
14. Grinding spindle head can be swivelled.
15. Component spindle head can be swivelled.

LONDON BRISTOL BIRMINGHAM MANCHESTER
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Contents

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INSTITUTION NOTES

August, 1952

Joint Production Management Course

Following the success of their Conference in November 1951 on "Management Production and Rearmament," the British Institute of Management and the Institution of Production Engineers will run an intensive residential course for senior executives of *small* firms (up to approximately 250 employees) in the engineering and general manufacturing fields. It is designed with special reference to firms undertaking defence contracts.

The subjects which will be dealt with are :—

Administration and Servicing of Government Contracts.

Material Supply and Control.

Production Management.

Quality and Inspection Requirements and Organisation.

Personnel Management.

The Course will be held at the College of Aeronautics, Cranfield, Bucks., and will last from Sunday afternoon, 21st September, to Saturday morning, 27th September, 1952, inclusive.

Tuition will be on the basis of a limited number of lectures by specialists, followed by tutorials and discussions conducted by a resident staff of highly qualified tutors. Special emphasis will be laid on laboratory work and practical demonstrations.

Each member attending will be asked to submit problems from his own firm some time prior to the course ; these will form the basis of the discussions and provide an opportunity for the exchange of experience. The whole course will be of an extremely practical nature.

Attendance will be limited to 48 (so as to enable 4 groups of not more than 12 members each to be formed). In the event of the demand exceeding the number of places available, priority will be given to firms on defence contracts.

The fee, inclusive of full board and accommodation, is £20, and application forms may be obtained from the Course Secretary, Institution of Production Engineers, 36, Portman Square, London, W.1.

Departure of 1952 Schofield Scholar

On 16th June, 1952, Mr. D. C. Howard, 1952 Schofield Scholar, left London to carry out in Switzerland and Germany his project on methods of telephone manufacture. The photograph shows (left) Mr. Walter Puckey, Chairman of Council, and (centre) the Secretary of the Institution, Mr. W. F. S. Woodford, with Mr. Howard immediately before his departure.

The Development of Technological Education for Production Engineers

In its Memorandum of December 1950 the Institution made strong recommendation for the development of " sandwich " type courses, so designed as to produce engineers who can approach the problems of production in a scientific and practical manner.

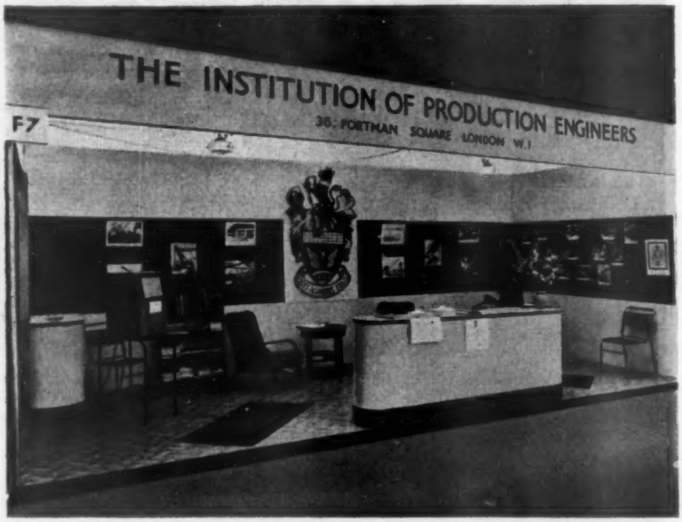
Since then a number of courses have become available in the London Region (see August 1951 Journal).

The North Gloucestershire Technical College, Cheltenham, now invites enquiries concerning a similar course which is commencing in September 1952. Those wishing to obtain places in these courses should get in touch with the Principal of the College concerned without delay.

Mechanical Handling Exhibition, 1952

Members who were unable to visit Olympia will be interested to see this photograph of the Institution's Stand, taken before the official opening.

A comprehensive selection of the most recent publications dealing with all aspects of mechanical handling was available for



reference, and an up-to-date bibliography was prepared specially for the Exhibition. (Copies of this bibliography may now be obtained from Head Office, price 1/- each post free.)

A feature which attracted much interest was the Rotavisor, showing film strips dealing with training in Materials Handling techniques.

Members of the Institution's Materials Handling Sub-Committee and of the Institution staff were in attendance throughout the Exhibition to deal with enquiries, of which it is estimated some 500 were received.

S.M.M.T.— New President

Mr. Henry Spurrier, Member, has been elected President of the Society of Motor Manufacturers and Traders for the year 1952-53. Mr. Spurrier, who is Managing Director of Leyland Motors Ltd., is the third Henry Sdurrier of the Company, his father having been founder and first Managing Director, and his grandfather the first Chairman.

Mr. Spurrier served for a considerable period on the Preston Section Committee and is one of the original members of that Section.

SOUTHERN SECTION DINNER-DANCE

The Southern Section held a highly successful Dinner-Dance — the first function of its kind in the Section — at the Polygon Hotel, Southampton, on 9th April, 1952. This photograph, taken during the Dinner, shows (*top table, left to right*) : The Worshipful The Mayor of Southampton; Mr. N. J. Cottell (Section President) and Mrs. Cottell ; Major-General K. C. Appleyard, C.B.E., (President of the Institution) and Mr. Freeman, Chief Education Officer, Southampton. In the foreground are Dr. and Mrs. Arman; Mr. and Mrs. Phorbe; and the Secretary of the Institution, Mr. W. F. S. Woodford, and Mrs. Woodford.

NEWS OF MEMBERS

Mr. J. Ayres, Member, until recently General Manager of Petters Ltd., Staines, has now been appointed Managing Director of that firm.

Mr. P. Ganguly, Associate Member, is now in charge of Planning, Progress, Rates and Estimating Section at the Metal & Steel Factory, Ichapore.

Mr. F. Ives, Associate Member, is now on the Mechanical Engineering Staff at African Explosives & Chemical Industries Ltd., Transvaal.

Mr. S. E. Parsons, Associate Member, is now Manager, Mechanical Department, Mole & De Kock (Pty.) Ltd., Port Elizabeth, S. Africa.

Mr. H. H. L. Ward, Associate Member, has been appointed Manager of Charles Churchill (Canada) Ltd., Toronto.

Mr. H. E. Witheford, Associate Member, has taken an appointment as a Senior Sales Engineer with Gailey & Roberts Ltd., Nairobi.

Mr. A. Gilmore, Graduate, is now Works Engineer of the Gateshead Works of British Ropes Ltd.

Mr. W. D. C. Huskisson, Graduate, has been promoted to Assistant Chief Draughtsman, E. K. Cole Ltd., Southend-on-Sea.

Mr. A. W. Stannard, Graduate, is now employed by the Aircraft Division of the Ford Motor Company of Canada, Windsor, Ontario, as a Process Planning Engineer.

Obituary The Institution records with profound regret the death of Mr. W. H. Brown, Member, Principal of Rotherham Technical College.

Mr. Brown, who joined the Institution in 1939, was a member of the Sheffield Section Committee and of the Research Committee, where he rendered invaluable service to the Institution, and his support and guidance will be greatly missed.

BIRMINGHAM GRADUATES' WORKS VISIT

Members of the Birmingham Graduate Section recently paid an official visit to the works of B.S.A. Cycles, Ltd. This photograph shows those who took part in the visit with Mr. J. A. I. Dickinson, O.B.E., Works Director (*centre, left*), and Mr. G. E. Bateson, Associate Member, senior representative on the Birmingham Graduate Section Committee (*centre, right*).

British Standards The following British Standards have recently been issued and may be obtained, post free, from the British Standards Institution, 24-28, Victoria Street, Westminster, London, S.W.1.:—

B.S.1714 Part 2: 1952.
Handling Carbon Black. Part 2: Discharge from Ships and Inland Transportation. (1/6)

B.S.1779: 1952.
Round Built-up Tins for Photographic Supplies. (2/-)

HAZLETON MEMORIAL LIBRARY

It would be helpful if, in addition to the title, the author's name and the classification number could be quoted when borrowing books.

ABSTRACTS

621.83. GEARS.

"Some Notes on the Modernisation and Reconditioning of Gear Hobbing Machines" by Admiralty-Vickers Gearing Research Association. *Bath, Dept. of The Engineer-in-Chief of the Fleet*, 1950. 39 *pages. Illustrated. Diagrams.*

The objects of the Admiralty-Vickers Gearing Research Association are the study and development of methods of manufacture of gears used by the Admiralty, particularly high speed turbine gears for marine propulsion, and this publication has a Foreword by the Engineer-in-Chief's Department, Admiralty.

Certain aspects of the work done and conclusions reached during the period from 1944 to the present day are covered. Some details are given of the type of errors existing on gears produced prior to 1943 and their magnitude.

An analysis is made of the cause of these errors and the steps taken to avoid them in hobbing machines of new design. The work includes details of the limits of error allowed in hobbing machines to British Standard 1498, issued in 1948. Desirable kinematic features for both creep and non-creep machines are given and reference is made to methods of finishing teeth of gears after hobbing. These include the operations of shaving and lapping.

The necessity for temperature control in the building and operation of hobbing machines is emphasised, together with the need for adequate foundations.

There is an outline of procedure in connection with reconditioning of hobbing machines and, although B.S.1498 is intended to apply to new machines only, it gives a guide as to what should be the target in such reconditioning.

A rough idea of the cost of overhaul, compared to the cost of new machines, is given, details of the method of checking alignments with typical test sheets for wheel and pinion machines, also cutting tests and allowable tolerances on such tests.

338.6. ORGANISATION OF INDUSTRY (Economic aspect).

"Ownership of Industry" by Hargreaves Parkinson. *London, Eyre & Spottiswoode*, 1951. 129 *pages.* 25/-

This book is a sequel to Mr. Parkinson's earlier publication, "Ordinary Shares"; in carrying out this further analysis of the industrial share market the author has established some interesting facts.

There are between 4,000 and 5,000 Companies registered on the London Stock Exchange, and Mr. Parkinson has, for his analysis, adopted, as being a representative cross-section of British industry, the 30 firms selected by the "Financial Times" for their daily Industrial Ordinary Share Price Index. Every tenth entry on the registers of these 30 Companies was noted, resulting in an estimated total of over 1,000,000 shareholdings, with a nominal capital value of some £347,000,000. The registers used in the analysis covered the years 1941 and 1942.

Mr. Parkinson asks what proportion of owners (in a typical British Company whose shares are actively dealt in on the Stock Exchange) hold large, medium and small holdings. He comes to the conclusion that nine-tenths of all holdings in British Industry are small, i.e. less than £500, and that only one-fifth of one per cent are large, i.e. £10,000 and over. On the other hand, this small minority owns nearly one-third of the total share capital. Who then are these large investors?

The author admits that there are certain classes of investors whose investment habits defy close statistical analysis. Nevertheless, in the following chapters he makes a study of the family holders, the "tactical" holders and the financial houses, and produces much data concerning the shareholding habits of each.

After a brief excursion into the field of "nationalised" industries the author sums up in his Moral for Investors. This is in effect a plea to all investors, and in particular to the small investors who make up nine-tenths of the total, to exert their power and influence as shareholders.

In his book Mr. Parkinson outlines the maxim that the greater the capital the more marketable the stock, and that as long as no considerable portion is family held, the more "democratic" the distribution. The tendency of market process, like that of the sea, is steadily to break down rock-like masses.

532.5 **FLUID MOTION**

"Pipe Resistance for Hydraulic, Lubricating, and Fuel Oils, and other Non-aqueous Liquids" by T. E. Beacham. *Spon, London.* 1951. 61 *pages. Diagrams.* 18s.

This book enables relationships to be formed between (a) flow, (b) pipe resistance and (c) bore of pipe, for various values of (d) viscosity of liquid, (e) roughness of pipe bore and (f) specific gravity of liquid, when the three latter are known.

The required information is presented basically, in the form of 21 Pipe Resistance Diagrams. Each Diagram deals with a pipe of certain material and finish and with liquid of certain viscosity and specific gravity.

Materials and finishes include steel, wrought iron, galvanized and drawn, the equivalent roughness being given in each case. Viscosity values range from 10,000 to 30 Redwood, and specific gravity from 0.90 to 0.82.

On each diagram, a family of about 25 curves is shown, each curve representing a different pipe bore in the range from 0.2 in. to 5 in. dia. approximately.

Rates of flow from 0.5 to 1,000 Imperial g.p.m. are given, and pipe resistances vary from 0.05 to 500 p.s.i. per ft.

The introductory part of the book explains the use of the Diagrams as drawn and provides supplementary information extending this use to conditions which are not covered directly.

The construction of the diagrams is discussed in an appendix.

534.1 **VIBRATIONS**

"Vibration and Shock Isolation" by C. E. Crede. *Wiley, N.Y., Chapman & Hall, London.* 1951. 328 *pages. Diagrams.* 52s.

This work, written from a practical outlook, commences with chapters on mathematical analysis of Isolation and descriptive detail. Cross reference

is made throughout the book and the practical engineer will have little difficulty in applying what appears a highly technical matter to practical use.

Many actual installations are described at length, among them electric motors, reciprocating machinery, internal combustion engines, presses, looms, vehicles and military equipment.

There are chapters devoted to the design of Isolators, and the properties of a wide range of suitable Isolation materials, in addition to the properties of rubber and its variations.

674 WOOD INDUSTRY; WOODWORKING MACHINERY

"Principles of Woodcutting Machinists' Work" by T. Hesp. *Longmans, Green, London.* 1951. 141 *pages. Illustrated. Diagrams.* 12s. 6d.

This volume caters for the needs of the apprentice wood machinist and covers the syllabus of the City and Guilds of London Institute up to the third year.

The range of woodworking machinery in general factory use today, is covered in detail by 10 chapters. Commencing with the fundamental principles of woodcutting, attention is given to the correct design and use of circular and bandsaws, together with the accompanying sharpening and maintenance. From this basis the theory and practice of both rotary and fixed knife planing is described, up to the more complicated cutterblock setting for Planing and Moulding machines. Separate chapters are devoted to the vertical spindle moulder, mortising and tenoning machines, high speed routers and types of sanding machinery.

A chapter on grinding machines and toolroom work enables the machinist to study the various techniques used in grinding, setting and balancing cutters and, coupled with this, a chapter on the geometrical developments required for the design of tenoning and moulder cutters completes the theoretical side.

Examples in wood machining calculations are given together with the answers in the final chapter. The text is illustrated throughout with line drawings.

658.5 PRODUCTION PLANNING AND CONTROL

"Modern Production Control" by A. W. Willsmore. (2nd Ed.) *Pitman, London.* 1951. 185 *pages. Diagrams.*

The author has made a complete analysis of the various complexities of Production Control. The information contained in this book is backed by the author's experience in the three fundamental types of manufacturing enterprise : jobbing shop production, batch production, and flow production. The principles of modern production planning and control in engineering works are discussed and defined in such a way that they may be understood by the student, and yet are still of immense interest to the experienced Production Engineer.

This second edition has been revised to include a section on scheduling, and minor additions have been added to other chapters to clarify fundamental points.

651 OFFICE ORGANISATION AND METHOD

"Office Management—The Task of Getting things Done." *Office Management Association, London.* 1951. 53 *pages. Diagrams.* 7/6.

This book contains the official report of the 1951 National Conference of the Office Management Association, which was devoted to consideration of the active problems of management—the task of getting things done.

The Papers presented are divided into two sections—those dealing with the organisation of an office, and those dealing with managing an office, in the latter case, a central office and a departmental office. The publication includes the rapporteurs' reports on the discussion sessions, and is illustrated with a number of organisation charts.

620.1791 NON-DESTRUCTIVE TESTING

"Magnetic and Electrical Methods of Non-Destructive Testing": Report prepared for the Magnetic and Electrical Methods Sub-Committee of the British Iron and Steel Research Association by D. M.Lewis. *Allen & Unwin, London.* 1951. 242 *pages. Illustrated. Diagrams.* 35/-

This book is divided into 4 parts—I Magnetic Particle Testing ; II Other Methods of Crack Detection ; III Magnetic and Electrical Method of Measuring Plate and Coating Thickness ; IV Magnetic and Electrical Sorting Methods.

Part I, to which nearly half the book is devoted, deals with the detection of cracks and of internal faults in castings, bar, sheet, rolled sections, etc., by various techniques involving magnetisation of the component and application of magnetic particles in the form of powder or fluid. Magnetising method (AC and DC), properties of magnetic powders and fluids, interpretation of the resulting particle patterns, testing and inspection procedures, and demagnetisation are discussed.

In Part II, DC coil methods, AC detection, and electrical resistance methods are described, and brief reference is made to R.F. testing which can be applied to non-magnetic metals. Part III covers the measurement of (*a*) coating thickness, both metallic and non-metallic, on metal bases ; (*b*) depth of case hardening ; (*c*) metal plate thickness measured from one surface only, and (*d*) sheet thickness, e.g. in rolling operations.

Part IV deals with magnetic (largely bridge-) and electronic methods for sorting materials by chemical composition and physical properties, including carbon content and hardness. The appendices include one on the selection of testing methods, arranged by components and types of defect. The book is written as a review, correlating the results obtained by over 250 workers in the field, and referring also to instruments commercially available.

621.7 WORKSHOP TECHNOLOGY

"Plant Engineering Handbook" by William Staniar (Editor). *McGraw-Hill Co. Inc., New York.* (Industrial Organisation and Management Series.) 2,007 *pages. Illustrated. Diagrams.* 1950.

This work has 35 sections, opening with costs and management and then leading from construction, power plants, transmission, instrumentation and control to maintenance, production processes and packing. Ancillary plant is dealt with fully as refrigeration, air conditioning, dust control, waste disposal, water treatment and means for fire prevention.

Details are given for piping (including rubber lined), bearings lubrication, grinding, welding, power distribution and measurement, lighting, speed control, drying out for materials such as glass, plastics and silicones. Full sections are given on heat transfer, vibration and its control, physics, including X-rays, infra-red and electronics, and graphical mathematics with nomographic charts and the use of determinants as a basis for these.

331.2 WAGES : PAY

"Methods of Wage Payment in British Industry" by Norman C. Hunt. *Pitman, London.* 1951. (Higher Studies in Commerce Series.) 160 *pages.*

The author deals with most forms of remuneration to be found in British industries, although the greater part of the book is devoted to the various types of financial incentives used. In the first two chapters a short account of the merits and limitations of non-financial and financial incentives are discussed and it is shown how such items as taxation, restrictionism, etc., can have an adverse effect on them.

The rest of the book deals with reasons for extending the Payment by Results method of remuneration, the extent of such systems in British industries, and the attitude of the Trade Unions towards them. Individual Piece Work System, Premium Bonus systems, Point Premium systems, Group

Incentives, Merit Rating, Profit Sharing, and Co-Partnership are each discussed under separate chapters, and a short summary is appended on the relative merits and demerits for their adoption.

In the concluding chapter, the author outlines a few of the essential requirements necessary in any incentive plan, and briefly states the types of incentive scheme most applicable to the different conditions of production.

621.8 MACHINE ELEMENTS : MACHINE DESIGN

"Principles of Mechanism" by F. Dyson. (4th Ed.) *O.U.P., London.* 1951. 368 *pages. Diagrams.*

This 4th edition of a book originally published in 1928 contains all that the original publications contained, but in addition there is some new work on clarifications of Coriolis Component. A clearly illustrated book containing 13 chapters, each carrying its own examples, with solutions as an appendix, an index, and a special chapter devoted to Quick Return Motion Acceleration Diagrams, this publication covers the work up to Part I of a University Degree Course.

OTHER ADDITIONS

621.94. LATHES; SCREW MACHINES

B.S.A. Tools Limited, *Birmingham.* **"B.S.A. No. 48 Single-Spindle Automatic Screw Machine: Operator's Handbook."** (2nd Ed.) *Birmingham, the firm* [n.d.] 40 *pages. Illustrated. Diagrams.*

B.S.A. Tools Ltd., *Birmingham.* **"B.S.A. No. 68 Single-Spindle Automatic Screw Machine: Operator's Handbook."** (2nd Ed.) *Birmingham, the firm* [n.d.] 35 *pages. Illustrated. Diagrams.*

B.S.A. Tools Ltd., *Birmingham.* **"Tools and Attachments for Single Spindle Automatic Screw Machines."** (2nd Ed.) *Birmingham, the firm* [n.d.] *Looseleaf. Illustrated. Diagrams.*

658. INDUSTRIAL ORGANISATION; MANAGEMENT

Fayol, Henri. **"General and Industrial Management"** by H. Fayol; trans. from the French ed. (Dunod) by C. Storrs. *Lond., Pitman,* 1949. 110 *pages. Diagrams.*

International Congress of Scientific Management, *no.* 9, *Brussels,* 1951. **"Rapports presentes aux sections, et Comptes rendus."** *Brussels, Comite national belge de l'organisation scientifique,* 1951. 2 *vols.*

658.54. TIME AND MOTION STUDY

Grainger, J. G. **"The Foreman and Time Study."** *Birmingham, Inst. Industrial Supervisors* [1952]. 23 *pages.*

658.562. INSPECTION; QUALITY CONTROL

Loxham, John. **"Control of Quality on Mass-produced Engineering Parts."** [1952.] 16 *pages. Illustrated. Diagrams.*

663.97. TOBACCO

Rogers, H. C. I. **"Engineering Aspects of Mass Production in the Large Cigarette Factory."** Paper to I.Prod.E. Western Section, Bristol. 1952. 9 *pages. Typescript.*

669.14. STEEL

Alleghany Ludlum Steel Corporation. **"Stainless Steel Handbook."** [n.p.], *the corporation,* 1951. 120 *pages.*

669.2. NON-FERROUS METALS

"Metal Industry Handbook and Directory." 1951. *Lond., Louis Cassier Co. Ltd.*

669.295. TITANIUM

Titanium Metals Corporation of America, *New York.* **"Handbook on Titanium Metal."** (4th Ed.) *N.Y., the firm,* 1950. 102 *pages. Diagrams.*

669.721. MAGNESIUM

Harkins, L. B. "**Magnesium Fabrication.**" *N.Y., Pitman*, 1947. 149 *pages. Illustrated. Diagrams.* (Pitman books on industrial materials and proceeses.)

690. BUILDING

Bessey, G. E. "**Floor Finishes for Industrial Buildings.**" *Lond., H.M.S.O.*, 1951. 28 *pages.* (National building studies: special report No. 11.)

744. TECHNICAL DRAWING

British Institute of Management, *London.* "**Drawing Office Organisation: formerly BS 1100: Part 9.**" (Rev. Ed.) *Lond., the institute*, 1951. 40 *pages.* (Production management series 4.)

PAPERS RECEIVED

1851: "Factory Layout and Flow Production" by R. Gore.
1874: "Increasing Productivity" by E. C. Gordon England.
1889: "Electric Lamp Manufacture" by S. R. Eade.
1890: "The Selection and Training of Foremen" by W. H. R. Dalley.
1892: "A Comparison of Product Finishes, with some reference to Costs" by C. D. S. Bridgett.

The Library—Saturday Opening Members are particularly asked to note that from 6th September, 1952, the Library will be open on Saturday mornings, from 9.30 a.m. to 12.30 p.m.

From Mondays to Fridays inclusive, the hours will remain 10.0 a.m .to 5.30 p.m.

Journal Binders Members are reminded that binding cases for the Journal are obtainable from Head Office, price 7/6 each post free. The cases, each of which will hold 12 issues of the Journal, are made of stiff board covered with imitation leather cloth, with gilt lettering on the spine.

Research Publications A number of copies of the following Research publications are still available to members, at the prices stated :

Report on Surface Finish, by Dr. G. Schlesinger	15/6
Machine Tool Research & Development	10/6
Practical Drilling Tests	21/-
Test Charts for Machine Tools, Parts 3 and 4	5/6 each

These publications may be obtained from the Production Engineering Research Association, "Staveley Lodge" Melton Mowbray, Leics.

Issue of Journal Owing to the fact thatoutput has to be adjusted to meet requirements, and in order to avoid carrying heavy stocks, it has been decided that the Journal will only be issued to new Members from the date they join the Institution.

Important In order that the Journal may be despatched on time, it is essential that copy should reach the Head Office of the Institution not later than 40 days prior to the date of issue, which is the first of each month.

ESTABLISHMENTS CONDUCTING HIGHER NATIONAL CERTIFICATE COURSES IN PRODUCTION ENGINEERING

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SCIENTIFIC AND MASS PRODUCTION ASPECTS OF RESISTANCE WELDING

by A. J. HIPPERSON, B.Sc.(Eng.), M.Inst.W.*

Presented to the London Section of the Institution, 13th March, 1952

WELDING, in one or other of its various forms, is now employed extensively in most metal-using industries and its advantages over mechanical methods of joining are well-known. Welded motor vehicles, bridges, ships and gas turbine engines are now accepted facts. The fabrication of high pressure boilers and other vessels by welding is not only a tribute to the quality of the results which can be achieved, but also shows how the use of welding provides the means for avoiding lap or butt strap joints with the accompanying elimination of rivet holes and economy in steel due to the thinner plates which can be used. In relatively recent industries such as those which manufacture automobiles and gas turbines, it will be found that almost all the main joints are welded, mechanical jointing only being used occasionally. Not much more than 50 years ago, however, none of the welding processes suitable for mass production had been invented, and the only welding process available was the age-old blacksmith's forge process.

It will be remembered that the modern welding processes can be divided into three main groups as follows:—

1. Processes using a flame as a source of heat such as the oxy-acetylene process.
2. Processes using an electric arc as a source of heat such as metallic arc welding. This is probably the best known and most widely used welding process at the moment.
3. Processes in which the heat for welding is produced by the passage of a heavy electric current through the work-pieces while they are held under pressure. These processes fall into a group generally known as the resistance welding processes, the outstanding virtue of which is that they are eminently suited to repetition work on account of the ease with which they can be automatised, and the inherently short time required for welding.

It is with the resistance welding processes that this paper is primarily concerned.

* *British Welding Research Association.*

The principle of resistance welding was first discovered by British-born Professor Thomson towards the end of the nineteenth century. The discovery occurred almost by accident while he was lecturing to a class of students at the Franklin Institute in America. He was demonstrating the function of a sparking coil consisting of a primary winding of a few thick turns of wire and a secondary winding consisting of a great number of turns of thin wire. By connecting a battery momentarily across the primary windings, he induced a very high voltage in the secondary winding from which he charged a Leyden jar. The question then arose as to what would happen if he reversed the process, i.e. what would be the effect of discharging the Leyden jar through the thin winding. Before doing this he connected the terminals of the thick primary winding together. When the Leyden jar was discharged through the thin winding, a very high current was induced in the thick and, due to the fact that the wire across its terminals was only in light contact with them, fusion took place firmly uniting the wire to the terminals. A weld had in fact taken place between the wire and the terminals. This experiment preceded the patenting of the resistance butt welding process by a matter of seven years, and in 1886 Professor Thomson took out his original patent for the first resistance butt welding equipment ever used, as shown in Fig. 1. This is a direct reproduction from Professor Thomson's original patent application in which the transformer is shown at the top in a diagrammatic fashion. It will be seen that the equipment is suitable only for small work due to the limitations of the spring which applies the butting pressure, and the limitations of the design of the machine itself. The method of operation of the equipment is as follows:—

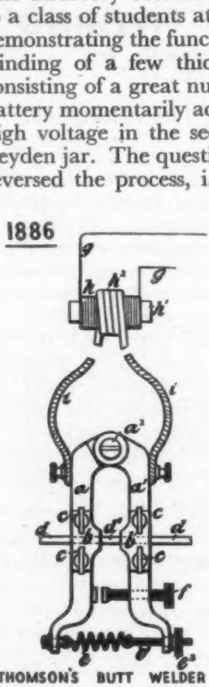


Fig. 1. Elihu Thomson's original butt welding machine 1886. (Reproduction from original patent application.)

A high current is passed through the work-pieces, which are in the form of rods firmly clamped by means of screws, and when the temperature reaches a sufficiently high level, the spring pressure is sufficient to cause upsetting and forging of the joint, the welding current simultaneously being switched off.

The principle as used in the first butt welding equipment has remained unaltered to this day, but naturally the electrical and

mechanical details of the equipment have been considerably improved. The main factors entering into the making of a resistance weld of any kind are as follows:—

1. The magnitude of the welding current.
2. The time for which the welding current is allowed to flow, and
3. The pressure on the work-pieces in the area where the weld is to be made.

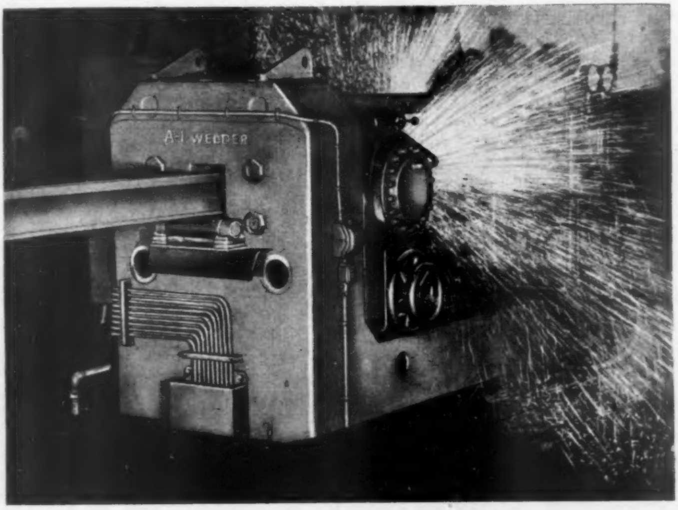


Fig. 2. Modern flash welder for high speed welding of rails.
(A.I. Electric Welding Machines, Ltd.)

Fig. 2, in contrast with Professor Elihu Thomson's butt welder, shows a modern butt welder capable of high speed butt welding of rail section. The actual process employed in this application is slightly different from Professor Thomson's butt welding, inasmuch as the ends of the work-pieces are brought initially into very light contact causing a flashing action between them whilst the current is passing as shown in Fig. 3. The weld is finally consolidated by the sudden application of a pressure of at least 4 tons per sq. in. calculated on the weld area. As its name implies, butt welding is essentially applicable only to those types of joints which are of the end to end variety and which involve similar sections either side of the place where the weld is to be made.

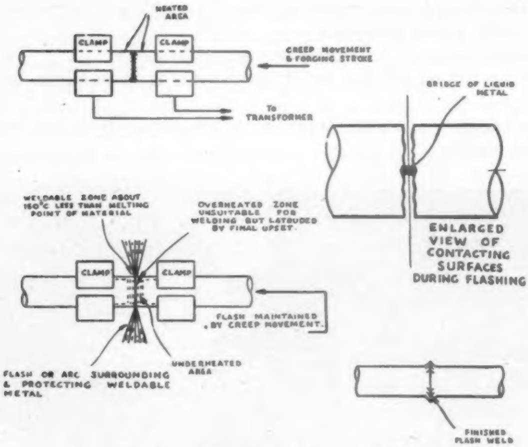


Fig. 3. Principles of flash welding.

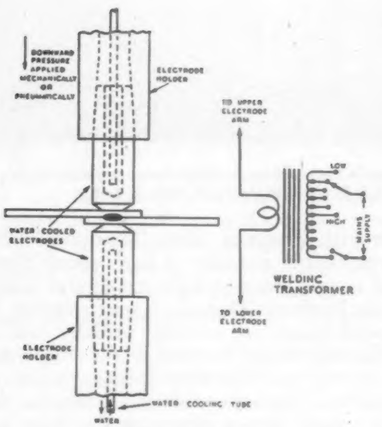
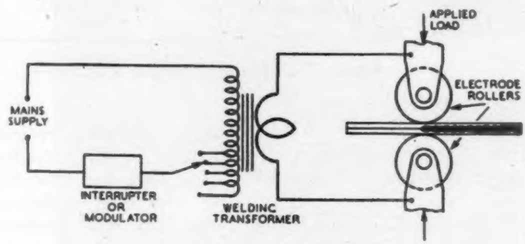


Diagram showing basic requirements for spot welds in mass production

Fig. 4. Principles of spot welding.

A logical development of the earliest form of butt welding was spot welding, which is suitable for joining sheets together. This involves the use of copper electrodes which apply pressure to the two sheets to be joined, as shown in Fig. 4. The current is then allowed to flow for a short period and pressure then released. A spot weld is obtained in the path of current flow, whose diameter is approximately equal to the diameter of the electrode tips producing it.

Other forms of resistance welding are seam welding and projection welding. Seam welding is similar to spot welding except that the electrodes are replaced by copper rollers and the rollers are rotated at the same time as the current is passing, in such a way that the



The principle of seam welding

Fig. 5. Principles of seam welding.

work-pieces are gripped between them as shown in Fig. 5. A series of spot welds are produced very rapidly and the speed of rotation of the rollers is such that the welds just overlap, thereby producing a continuous welded seam. Speeds of welding of 10 ft. a minute on thin sheet are not unusual.

Projection welding is another modification of spot welding and the details of types of welds are shown in Fig. 6. In this process flat electrodes are used which apply pressure to an appreciable area of the overlapping work-pieces which already have been provided with projections. These projections localise the current and hence spot welds are produced at each point where there was originally a projection. The advantage of this process over the ordinary spot welding process is that more than one spot can be made in one cycle of operations of the welding machine.

Undoubtedly the most widely used resistance welding process at the moment is spot welding, and the greater part of the following remarks will be confined to the spot welding process.

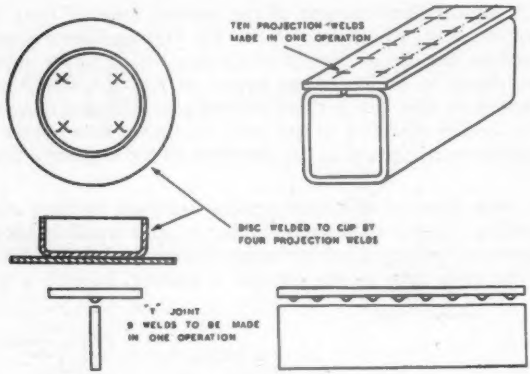


Fig. 6. Examples of projection welding.

Fields of Application of Spot Welding

A modern general purpose type of automatic spot welding machine is shown in Fig. 7. This machine is capable of producing 100 spot welds per minute between two steel plates whose added thickness is about $\frac{1}{8}$ in. This type of machine can be used for a variety of purposes but the work involved must always have one thing in common, i.e. it must be capable of being brought to the machine and therefore of reasonably light nature. Where work intended for spot welding cannot satisfactorily or easily be brought to the machine, portable machines are required so that the machines can be taken to the work. A typical example of a general purpose type of portable spot welding machine used in the automobile industry is shown in Fig. 8. These two machines indicate, in a very broad sense, the versatility of spot welding but there are limiting factors as to its use, primarily the thickness of sheet and secondly the material of the sheet. Mild steel is easily weldable owing to its reasonably high electrical resistance but copper is very difficult to resistance weld, except by butt welding, due to its low resistance. Materials of intermediate electrical resistance are welded with varying degrees of success; for instance, certain brasses and bronzes can be resistance welded as also can many of the aluminium alloys, nickel base alloys and heat and corrosion resistant steels. A normal maximum added thickness of about $\frac{1}{2}$ in. is appropriate to mild steel, but by far the great proportion of spot welding work is applied to sheet of the order of 16, 18 and 20 s.w.g. Undoubtedly it is in these instances where the greatest possible economies can be effected by the use

of resistance spot welding. It is not surprising, therefore, to find that nowadays most of the welding used in automobile construction is spot welding; and sheet metal fabrication such as steel furniture, holloware, gas turbine engine components and the like, are largely spot welded.

Fig. 7. Modern general purpose type of automatic spot welding machine.

Scientific Aspects of Spot Welding

A large proportion of the research and experimental work conducted in this country in the last few years on resistance welding has been directed towards the general problem of improving the quality of welds and the consistency of weld strength.

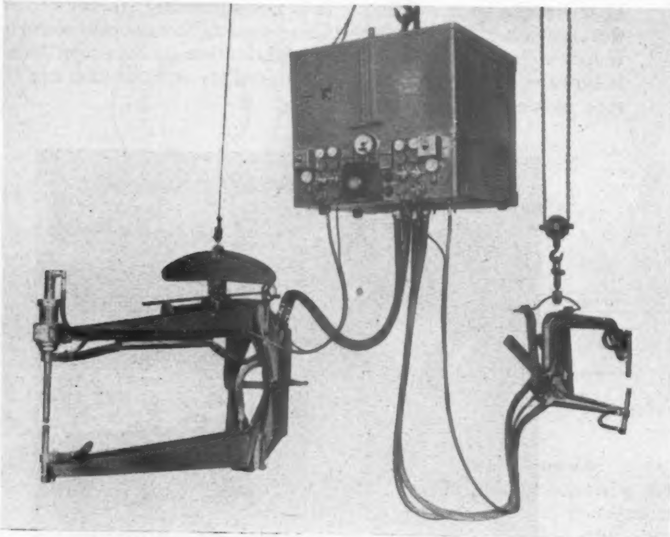


Fig. 8. General purpose portable spot welding machine as used in automobile industry (Sciaky Electric Welding Machines Ltd.).

As regards spot welding in particular, much has now been done to rectify the position of disrepute into which this process was tending to fall as a result of the inferior results obtainable from inexperienced operators, and from machines equipped with inefficient control gear.

One of the first reactions experienced by newcomers to spot welding is that the process does not usually appear effectively to fuse the metal of the components, and owing to the fact that the cycle of operations of the machine required to complete a weld is over in such a very short time, the whole business is eyed with a great deal of suspicion. The newcomer's subsequent experience proves that the spot welding machine, properly set, produces welds which, when tested to destruction, will tear the parentds' we rather than fail through the weld. Sections cut through such metal reveal good, cast weld nuggets, reasonably free from porosilty and of the specified size. Fig. 9 shows the dimensions of a section of a spot weld, these dimensions having now become regarded as standard for mild steel.

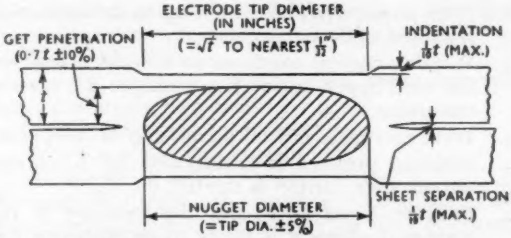


Fig. 9. Standard spot weld dimensions (B.W.R.A.).

The first requirement of good quality spot welding is, of course, good quality equipment. It is imperative that such equipment is of ample capacity for the work in hand, both electrically and mechanically. Even for the welding of mild steel, which can be regarded as being the material most ideally suited to spot welding, B.S. 1140 makes it quite clear that the operation of the welding machine should be entirely independent of the operator, whose sole responsibilities should be confined to loading or positioning the work for spot welding, and to depressing the initiating switch which sets the machine in operation. The actual cycle of operations automatically performed by the machine once the initiating switch has been depressed should be as shown diagrammatically in Fig. 10, as follows:—

1. Head pressure is applied, causing the electrodes to apply force to the work-pieces.

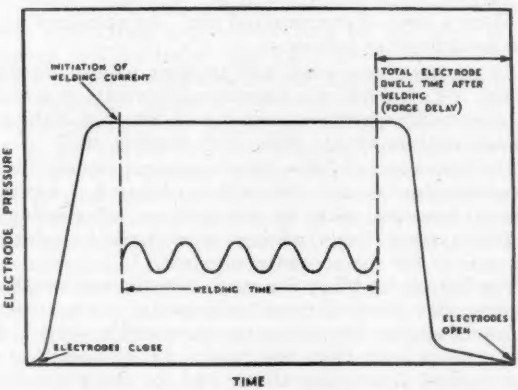


Fig. 10. Cycle of operations of spot welding machine.

2. After pressure has been built up on the work, welding current is caused to flow.
3. Welding current continues to flow for a time determined by the weld timer, which has been pre-set, pressure still being maintained.
4. Weld current is cut off at the end of the pre-set time.
5. Welding pressure is maintained for a minimum of 1/20 second after current is cut off.
6. Pressure is released, and the machine is returned to a condition where it is ready to recommence the same cycle of operations.

For materials other than mild steel, the cycle of operations may be different from the foregoing. For instance, spot welding machines for aluminium and its alloys may be provided with means for a variable pressure cycle, so that the load applied to the work is not constant, but follows a definite changing pattern during welding. A.C. welding current may now be provided by means of a simple welding transformer; to-day, stored energy machines are often more popular owing to their very much lower demand on the supply mains. One of the latest light alloy spot welders which is at present exciting a good deal of interest is one incorporating a new three-phase system, and in which immediate adjustments are possible to current wave form, a balanced load is presented to all three phases of the mains, and the actual kVA demand is extremely small in relation to the output of the machine.

The second requirement of good quality spot welding is the use of optimum machine settings. A large number of combinations of current, time and pressure are available, many of which will produce a weld of the required size. An optimum machine setting can be defined as follows:—

"*A machine setting which will produce a weld of the required size and quality, and which will give a minimum of variation in weld size and quality when unavoidable variations occur in such factors as supply voltage, air line pressure, electrode tip size, fit-up of the assembly, etc.*"

The importance of the use of optimum settings for spot welding in production cannot be over-emphasised. Optimum settings cannot, however, make up for deficiencies in welding equipment and component design, neither can they put to rights negligence on the part of the maintenance engineer.

The British Welding Research Association's work on resistance welding has been directed principally to the determination of optimum settings for various processes and materials. For instance, best settings have been determined for spot welding of mild steel and various aluminium alloys, and for the projection welding of sheet steel components and studs and bolts to sheet. As an example

of the enormous amount of work this involves, the relatively simple question of the determination of optimum settings for welding mild steel will now be discussed.

In the spot welding of mild steel, three principal machine variables are involved, namely:—

1. Magnitude of welding current.
2. Duration of welding current.
3. Magnitude of welding pressure.

Obviously, the higher the welding current used, the greater is the heat generated, and the longer the time of current flow, the greater again will be the amount of heat generated. High pressures produce less heating than low pressures, all other factors remaining constant, because of the decrease in contact resistance thereby obtained.

The procedure in the early days was to select at random machine settings which were thought might be appropriate for a given application and after a few trials, one or other of the welding variables would be altered to attempt to obtain the type and size of weld required. In the absence of suitable measuring instruments, these trial and error methods were very hit and miss, and even when apparently satisfactory settings had been obtained, there was no guarantee that these settings would give greatest possible weld strength consistency from one weld to the next. Again, each different application involved such trial and error methods, which, in turn, involved a considerable amount of time waste, uncertainty still being present even when production was commenced. By virtue of these facts, the B.W.R.A. saw fit to put in hand extensive series of investigations to define once and for all the effect of each of the welding variables, and to define optimum machine settings, thereby largely eliminating exploratory tests on the part of the user of resistance welding before starting a new job, and giving him the satisfaction of knowing that the use of such optimum settings would ensure optimum results.

Briefly speaking, the larger part of this experimental work was done by the old but infallible slogging method of determining the effect of different values of each variable, keeping all others constant while the one under consideration was being examined. At each setting used, ten single spot weld specimens were made, all values of machine settings were recorded, and details taken of the weld size, strength and surface indentation. In this way, not only was it possible to determine the average results produced by each machine setting, but it was also possible to determine the consistency with which welds could be produced at each setting. The test procedure was as follows:—

Using a given transformer tapping, and setting the weld time to one cycle, ten welds were made for subsequent strength testing

by the tension shear test. The weld time was then increased to 3 cycles, and a further set of specimens were made. This was continued in the case of 2 x 14 s.w.g. mild steel sheet, up to 40 cycles, the pressure and current being kept constant all the time. All the specimens were then tensile tested, and the average weld strength was plotted against welding time, as shown in Fig. 11. This was repeated for various values of welding current, keeping electrode pressure constant. In this way, various curves relating weld strength to welding time were obtained, each being at a different current. By careful examination of additional specimens and observations of welding characteristics, it was possible in this graph to insert certain boundaries or parameters within which reasonably satisfactory welds could be obtained. The area shown shaded in the graph represents these reasonably satisfactory conditions, and is bounded at the bottom by a line of insufficient fusion, or by a line outside of which the maximum weld strength scatter at any setting exceeds ± 10 per cent. of the average value obtained at that setting. The area is bounded at the top by a curve above which the surface indentation caused by the electrodes exceeds 10 per cent. of the sheet thickness, or by a line above which excessive metal expulsion occurs from the weld. The graph is representative only of one electrode pressure, namely, 10,000 lb. per sq. in., and so the entire experiments were repeated for other values of electrode pressure, viz. 5,000, 15,000 and 20,000 lb. per sq. in. In this way, complete data became available covering a wide range of current, pressure and time, from which it was possible to specify a single optimum setting for 14 s.w.g. sheet.

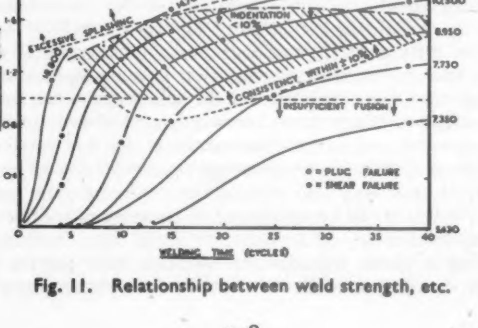


Fig. 11. Relationship between weld strength, etc.

Further tests covered 20, 18 and 16 s.w.g. sheet, and work now in hand is devoted to 24 and 12 s.w.g. sheet, from which it can be seen that the range now covered should include most industrial applications of spot welding.

A series of graphs was obtained from this work similar to that shown in Fig. 11. Obviously, some portions of the shaded area are better than others from the production point of view. For instance, short times are preferable to long, but the drawback to very short times is that the slope of the strength/time graph is steep. Again, settings towards the lower boundary are undesirable because a slight drop in line voltage would drop the welding current to a dangerous value. Taking all these things into account, it may be said that the optimum values finally recommended are reasonably well on the flat portion of the strength/time curve, and are high in the shaded area. These recommended settings for mild steel are shown in Table I, which covers thicknesses from 14 to 20 s.w.g. inclusive.

TABLE I

Optimum Settings for Welding Two Equal Thicknesses of Low Carbon Mild Steel Sheet.

Sheet Thickness *in.*	*s.w.g.*	*Electrode tip dia. (in.)*	*Electrode force (lb.)*	*Weld time (cycles)*	*Welding current (amps.)*	*Weld Strength (lb.)*
·036	20	$\frac{3}{16}$	275	10	8,000	1,100
·048	18	$\frac{7}{32}$	375	15	9,000	1,400
·064	16	$\frac{1}{4}$	500	17	9,000	2,200
·080	14	$\frac{5}{16}$	770	20	12,000	3,700

This type of experimental work in various fields of resistance welding can be said to be of direct interest to the Production Engineer, because it puts at his disposal machine settings which are based on sound principles, and it gives him the opportunity of proceeding without worry as to the possibility of the existence of better settings. The work also brings out the importance of other factors such as details of installation and maintenance of resistance welding equipment, which summarised are as follows:—

1. The electrical supply and mains wiring should meet the requirements of the equipment.
2. Automatic plant is preferable to manually operated equipment, but timers, air valves, solenoids, etc., must be effectively maintained.

3. **Internal water-cooling of equipment, particularly electrodes, is of primary importance.**
4. Electrode tip shape must be properly maintained.
5. Good electrical contact between the parts of the secondary circuit of the machine where current is very high is of considerable importance in helping to ensure constant welding current.
6. Care must be taken to ensure that jigs forming current carrying parts of the secondary circuit should be of high conductivity material, and care must be taken in their design to ensure that they do not by-pass welding current.

Mass Production Aspects of Spot Welding

The outstanding virtue of spot welding from the production aspect is the incredibly short time required to complete a weld. For instance, in spot welding two steel sheets, each 20 s.w.g. in thickness, welding current is flowing for a matter of ten cycles, that is 1/5 second, and in a well-designed machine, the overall time for the complete cycle of operations between the electrodes closing on the work and returning to their original position may be only 2/5 second. All too often, the enormous productive potentialities of resistance welding are lost by inefficient handling methods and unsuitable or non-existent jigs. Spot welding is, as its name implies, an intermittent process, involving the handling and positioning of the work-pieces and sometimes the welding machine itself. Even in a long spot welded seam, it is not unusual to encounter spot welding speeds reaching only a maximum of 20 welds per minute. This means that 3 seconds are required for each weld, during which time welding current is flowing for only 1/5 second, and the duty cycle of the welding transformer is as low as 7 per cent. The Production Engineer who allows his welding equipment to operate under these grossly inefficient conditions consoles himself with the fact that the total cost of making 1,000 welds is still less than four shillings. This assumes the use of a small general purpose automatic spot welder, operating for a 40 hour week for 50 weeks in the year, and includes:—

10 per cent. machine depreciation;
Operator's time;
Cost of electricity, compressed air and cooling water;
Cost of electrode materials, redressing and replacement.

In the spot welding of aluminium alloys, as distinct from clean bright mild steel sheet such as is used in the automobile industry, many other additional operations are required, principally those connected with the removal of the surface oxide film. Unless this oxide film is removed, weld strength is erratic, and electrode

tip contamination is pronounced. The preparation of the aluminium sheet for good quality spot welding involves at least a degreasing operation and a cleaning operation. These additional operations reduce the prospective savings of spot welding of light alloys as compared with riveting, but, even so, economies can still be effected. A recent examination by the Society of British Aircraft Constructors compared the cost of spot welded hatch covers with riveted ones. These hatch covers were 8 feet by 3 feet, containing 534 rivets or welds which attached " top-hat " stringers to a 22 s.w.g. alclad skin. The detailed comparative analysis of costs showed that the saving by spot welding was 54 per cent., that is to say, riveting costs were more than double spot welding costs.

Spot welding with general purpose equipment is often necessary where a variety of work has to be catered for on a single machine. In large quantity production, however, special purpose equipment can give better results economically, due to the fact that production costs can be cut by the savings in man-hours. It will have been observed that the general purpose spot welder makes only one weld in each cycle of operations, since only one pair of electrodes is used. If more than one weld is made at one time, however, obvious economies can be secured, provided always that additional manpower is not involved. In the last few years, machines with two, four and even more heads have been creeping into use, culminating in the large multi-point spot welders installed by some of the most progressive of our motor manufacturers, in which hundreds of welds are made in one operation.

The main difficulty which presents itself to the prospective user of such large resistance welding machines is the high capital cost of the equipment, but this would not be an insuperable problem if the machine could remain in use for a number of years. In automobile construction, design changes necessitate different electrode arrangements, and, on the face of it, this would seem to involve scrapping old equipment and installing new when component design changes arose. This problem has been largely overcome by using compact, standard transformers, standard electrodes, and standard hydraulic guns and standard fittings, so that a design change can be catered for simply by re-orientation of the detailed equipment, besides simplifying maintenance.

Modern large multi-point spot welding machines fall into three main groups, namely:—

Hydromatic machines;

Ultra-speed machines;

Multi-transformer machines.

The most popular and versatile of these is the multi-transformer

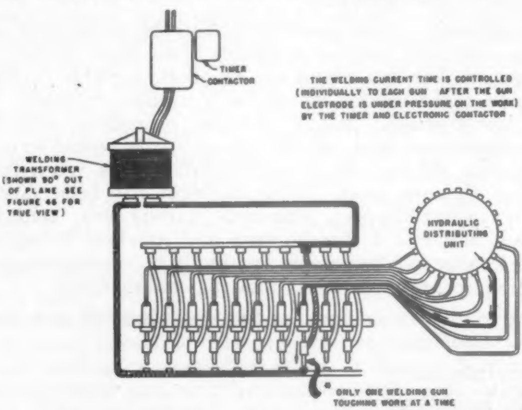
system, and multi-spot welding machines in use in this country at the moment are almost entirely of this type. All three types have several things in common, however, as follows:—

They are all automatic in operation;

All processes have welding guns which are hydraulically operated.

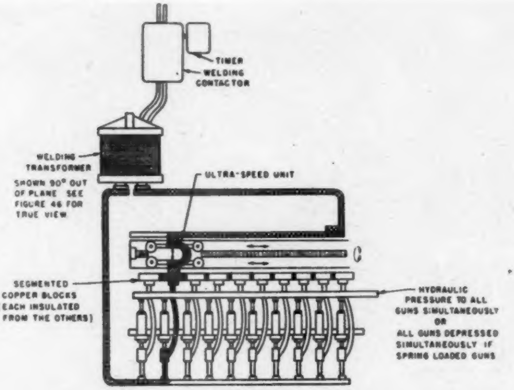
The need for automatic operation in multi-point welding is obvious in the interests of speed and accuracy in sequencing the various electrical and mechanical operations. Hydraulic operation of each electrode assembly is necessary in preference to air operation for reasons of space economy. Hydraulic cylinders are normally between 1 and 1½ inches in bore, operating at 150 to 350 lb. per square inch, whereas corresponding air cylinders to give the same force with an air line pressure supply of 80 lb. per square inch would have to be many times larger. Welds are often so closely pitched as to preclude the use of air cylinders, bearing in mind that each electrode must have its own individual cylinder to ensure the correct pressure at each point.

The hydromatic machine is one in which the electrodes make contact with the work in rapid succession, not more than one electrode or one set of electrodes being in contact with the work at any given time. This arrangement allows the use of a single transformer and a common electrical mounting for the moving electrode assembly. A hydraulic distribution system controls the sequence in which the electrodes operate, and welding current can only pass through that electrode in contact with the work. Fig. 12 illustrates the principle of the hydromatic machine.



Schematic view of the hydromatic system for automatic spot welding.

Fig. 12. Principle of hydromatic welding machine.



Schematic view of the ultraspeed system for automatic spot welding.

Fig. 13. Principle of ultra-speed welding machine.

The ultra-speed system differs from the hydromatic system in that all electrodes are brought into contact with the work simultaneously, instead of mechanically operating them in sequence. Basically a single transformer is still used, however, and spot welds are made in rapid sequence by commutating welding current from one electrode to the next by means of a special secondary current distribution switch, as shown in Fig. 13. A timer is so arranged that the transformer is fired during the time that the moving brush is in contact with a segment of the commutator. A typical ultra-speed machine for welding together two car door half-pressings is shown in the illustration, Fig. 14. The 90 welds around the door are made in 15 seconds, allowing 6 cycles for each weld and 4 cycles " off " time in between each. Since two doors are welded simultaneously, one on either side of the machine, the overall result is that 180 welds are made in 15 seconds, and one operator can look after the entire machine.

The principle of the mutli-transformer spot welding machine is illustrated diagrammatically in Fig. 15. Series welding is used extensively in the multi-transformer method, in which two welds are made with each transformer secondary winding. All electrodes apply pressure to the work simultaneously, and all transformers can be fired simultaneously provided the mains supply is adequate; alternatively, the transformers can be fired in groups.

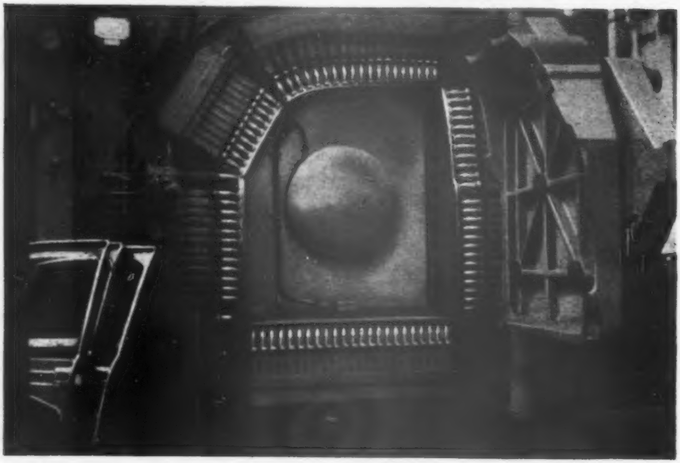
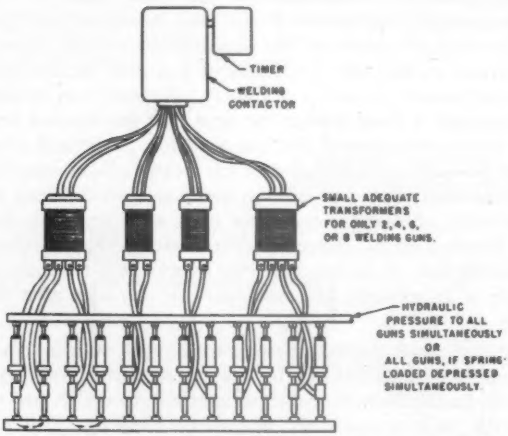


Fig. 14. Typical ultra-speed machine used for welding automobile doors (Volkswagenwerke).



Schematic view of multiple-transformer system for automatic spot welding.

Fig. 15. Principle of multi-transformer welding machine.

The Multi-Transformer System

In addition to the enormous production capabilities of the multi-transformer system, it is of importance to note that the positioning of each weld is very accurate, and distortion due to welding is almost entirely eliminated, since all electrodes apply pressure simultaneously. This raises another interesting feature, that is, the total load applied by all the welding guns. If, for example, each hydraulic gun applies a force of 500 lb. to each electrode, and assuming 100 guns on a machine, the total reaction is 50,000 lb., or over 200 tons. This accounts for the very robust and press-like appearance of the multi-transformer machines, and the fact that they are commonly referred to as " press-welders."

Two main types of press-welding machines have been installed in the new Vauxhall production line, the four pillar type and the open-faced type. Fig. 16 shows a four pillar type of press welder, which weighs 12 tons, and is built to withstand a 30 ton reaction from the force applied by all the welding guns. It is an upstroke machine, and the lower platen can be raised and lowered through a distance of 18 in. to give the necessary clearance for loading the components to be welded into position, and for ejecting the welded assembly afterwards. The stroke of the hydraulic guns carrying the electrodes is very small, rarely exceeding one inch. The motive power for raising and lowering the table is supplied by a 10 h.p. electric motor situated on the crown of the machine, and it imparts motion to the table through a two-throw crankshaft and a system of connecting rods and levers, in such a way that the table is virtually mechanically locked in the " up " position when ready for welding.

The machine is provided with its own self-contained hydraulic unit for supplying pressure to the welding guns. The unit consists of a hydraulic pump, an accumulator, and various solenoid operated and change-over valves, and much of this can be seen on top of the machine. The welding controls are housed in a steel cubicle not shown in the illustration, and include an auto-transformer, heat control switches, ignition contractors, and a mechanical timer for operating the welding sequence. With these new machines, it has been possible to economise greatly in floor space, and to halve the number of operators required for door production. The door assembly line is a continuation of the press shop line, so that the pressed panels pass in a continuous flow into the welding assembly line. The welding line includes five press welding machines, and mechanical handling methods between machines have received special attention, in addition to automatic ejection of welded assemblies from some machines. The line has been designed to manufacture all four doors, and the luggage trunk lid, so that five complete changes of tools are involved on the machines, a change

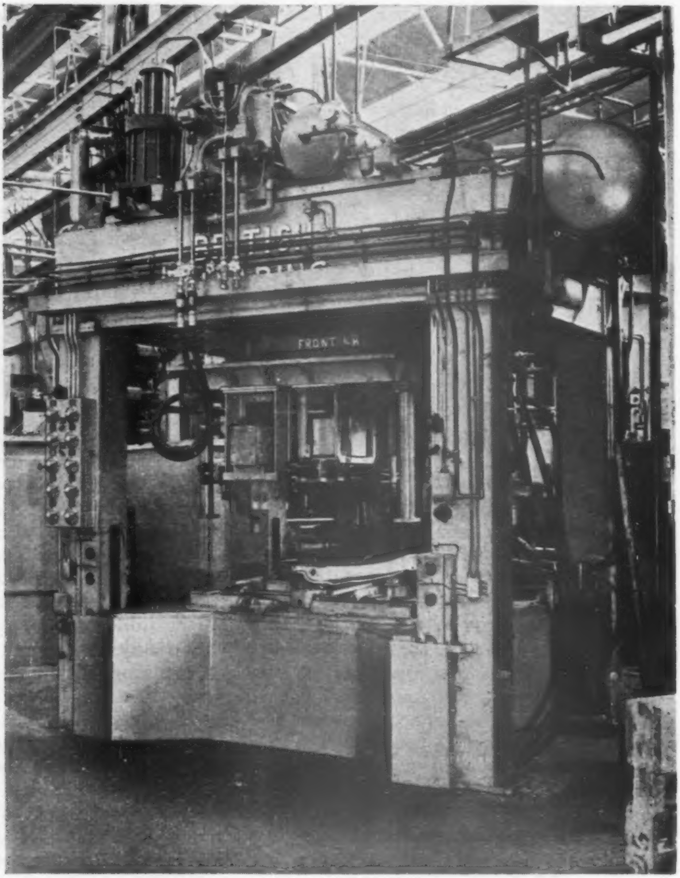


Fig. 16. Four pillar type press welder (Vauxhall Motors).

occurring every few days. Tool changing may at first appear to be a formidable task, but this is not so. Each set of tools is a unit in itself, which can be very quickly unloaded from the press by means of a five-ton fork lift truck. During its idle period, each set of tools is serviced by the maintenance department ready for the next production run.

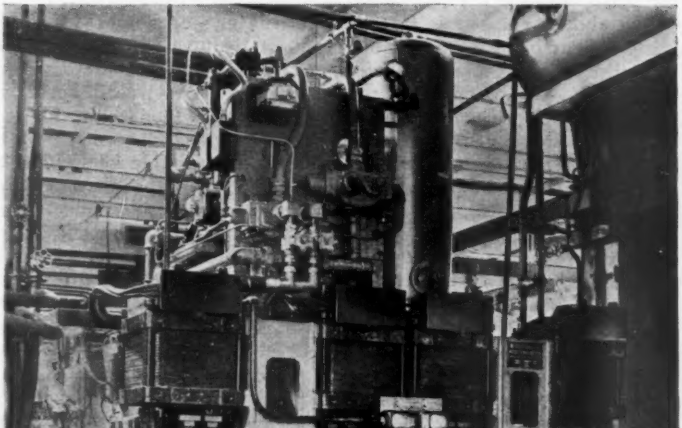


Fig. 17. Smaller open-faced press welder (Vauxhall Motors).

A most important feature of the multi-transformer press welding machine is the design of the transformers. They must be extremely compact and robust, yet give ample output to cover all classes of work. The transformers used are standardised, and are of 30 kVA capacity, and occupy less than ½ cu. ft. The core is of " Hyperil " material, the flux density being 17,000 lines per sq. cm. as compared

with about 11,000 lines for ordinary transformer primary; current adjustment being obtained by the master auto-transformer in the control cabinet. Each transformer has two single-turn secondary windings, each capable of producing two series welds, i.e. each 30 kVA transformer can produce a maximum of four welds. Fig. 17 shows a relatively small open-faced press welder, capable of withstanding a maximum reaction of 5 tons. It is suitable for welding a large variety of small components, not only those encountered in the motor industry, but also many other spot welded sheet steel assemblies.

Multi-point machines involve no new welding principles. They are but a logical development of the earlier spot welding machines, taking into account, as they do, the need for cheaper and faster production. They have given Electrical, Mechanical and Production Engineers many headaches in their development, but the final result achieved is worthy of a great deal of admiration. Owing to their very high initial cost it is not economical to use them on anything but mass production work, but where such production is required, their use carries with it a very high output, substantial reductions in floor space and number of operators, practically no distortion, and a product of the highest quality and consistency.

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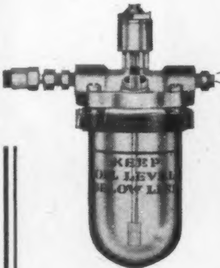

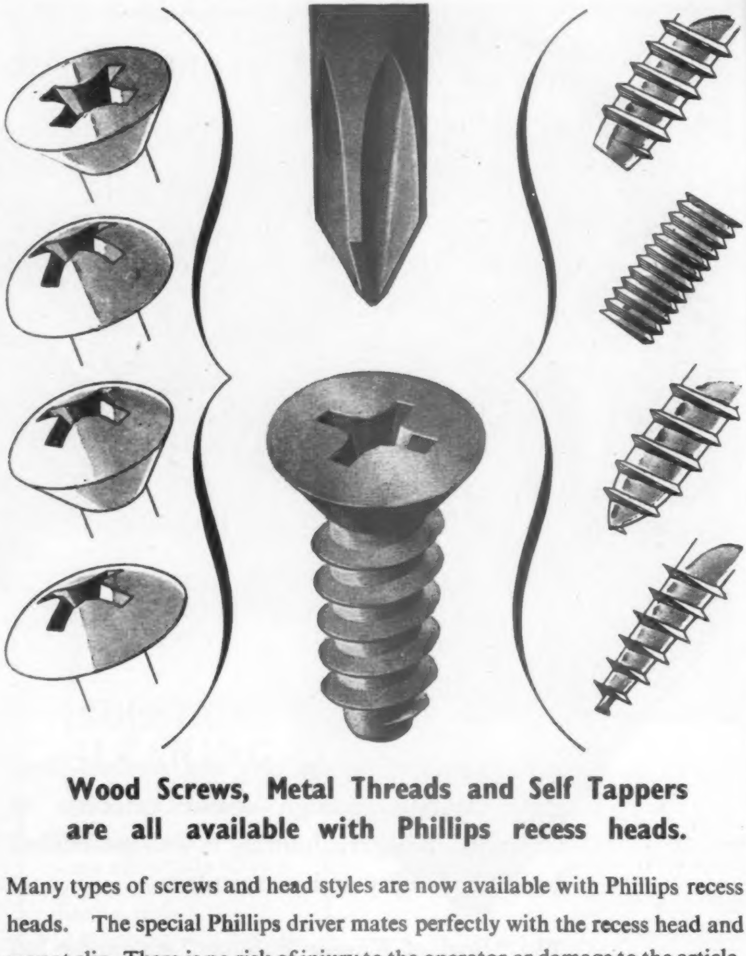

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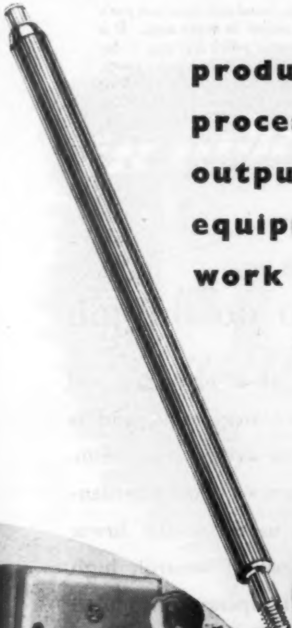

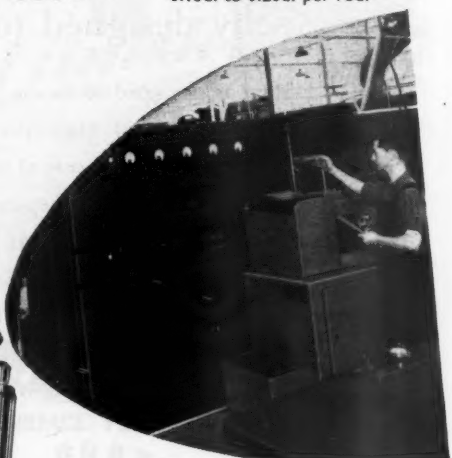

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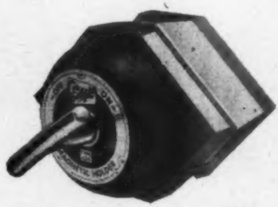

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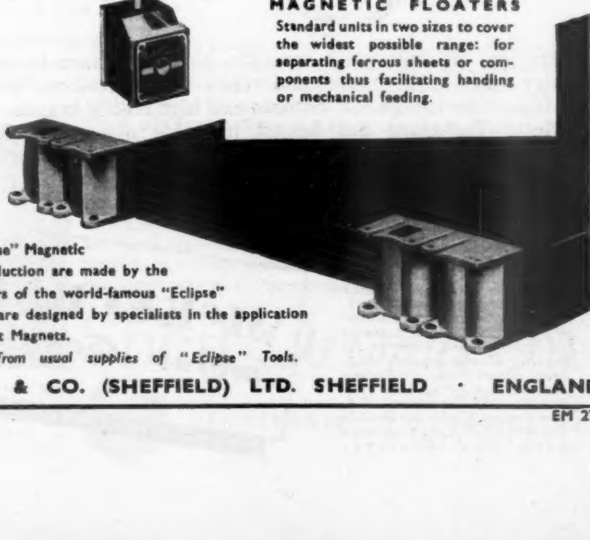

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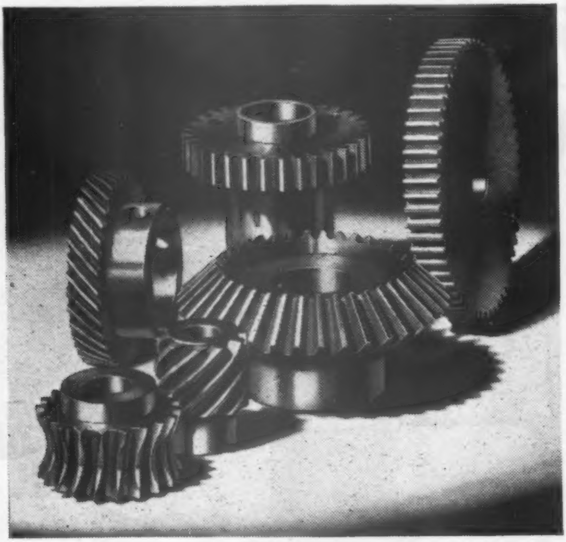

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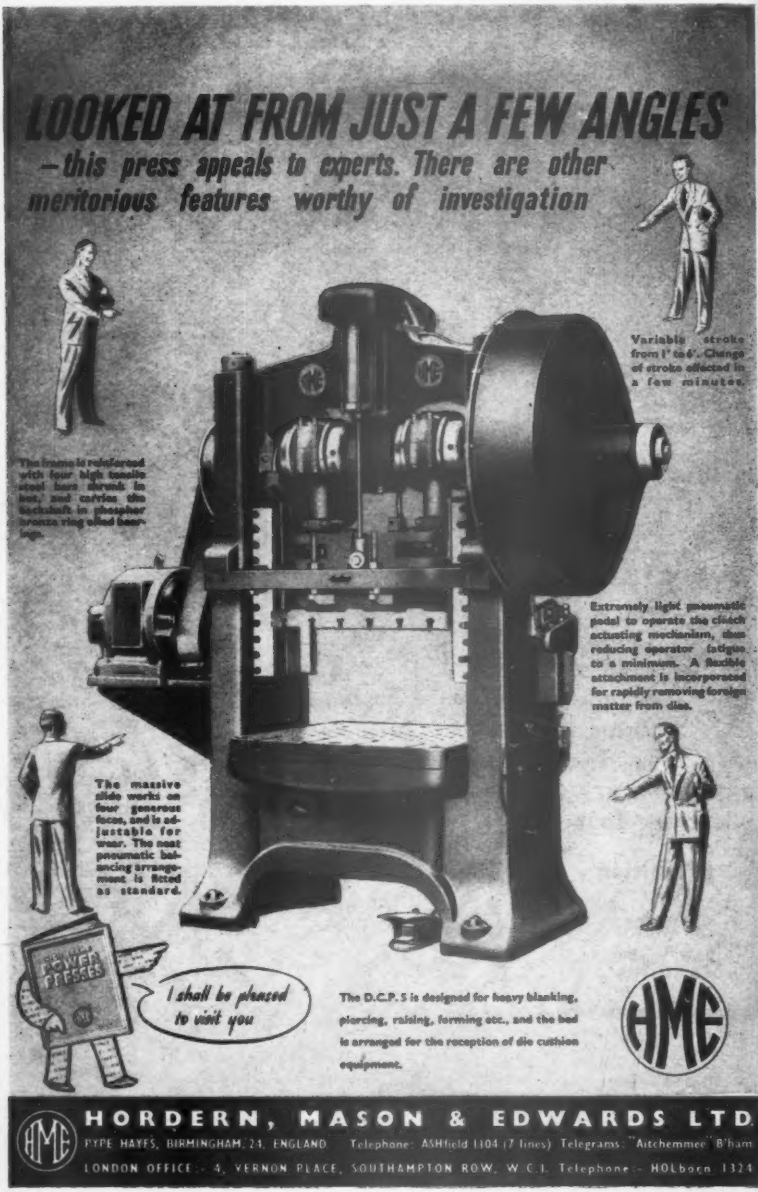
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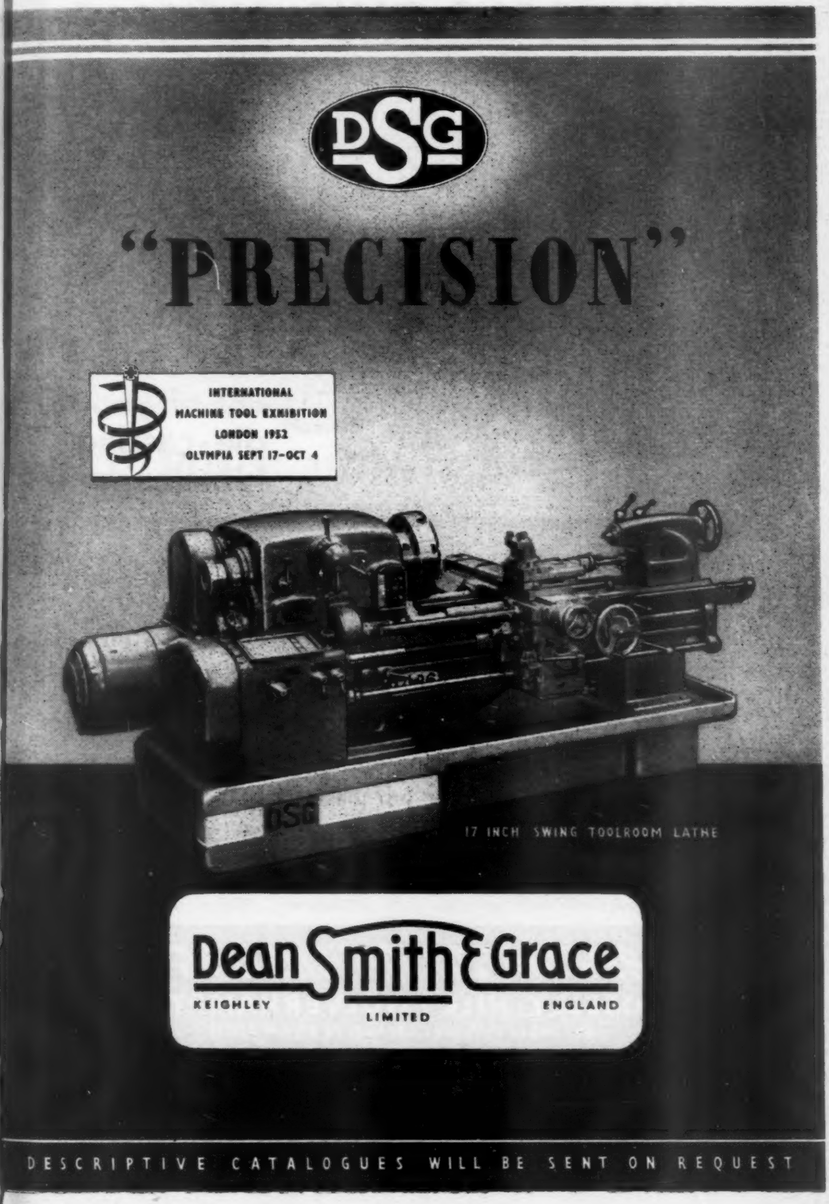
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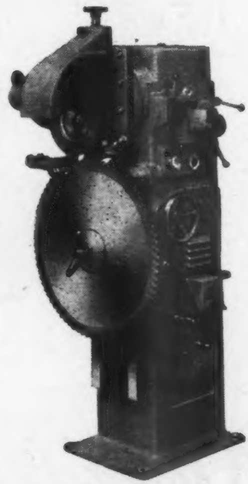

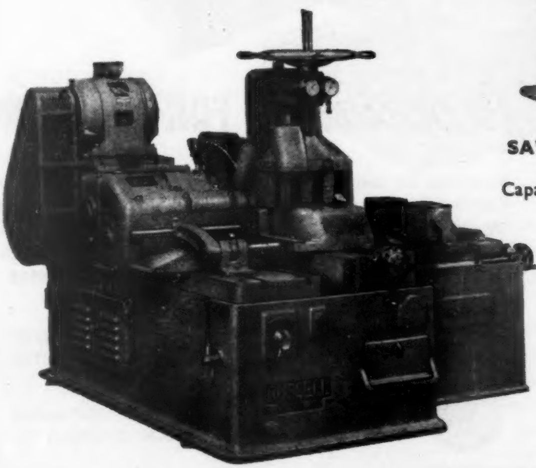

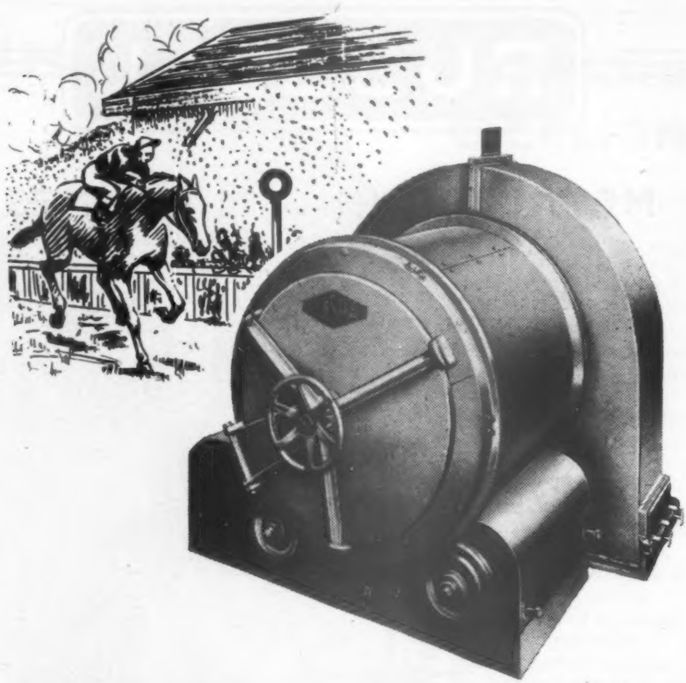

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MULTI-SPINDLE DRILLING MACHINES

- ★ EQUALLY SUITABLE FOR SMALL BATCHES OR MASS PRODUCTION
- ★ FOR DRILLING, REAMING, COUNTERBORING & TAPPING
- ★ PUSH BUTTON CONTROL—SEMI-AUTOMATIC CYCLE
- ★ THREE BASIC SIZES WITH UP TO 40 SPINDLES
- ★ CAPACITIES UP TO 1¼" DIAMETER IN STEEL

Owing to their rigid construction and use of flange motors, ensuring the shortest possible distance between driving and driven members, these machines run quietly even under conditions of heavy load. The semi-automatic cycle is push button operated and includes rapid approach and automatic return of the head which is controlled by accurately adjustable depth stops. These machines can be equipped with intermittent feed for chip clearance and with adjustable or fixed drill spindle bearings.

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AN INTEGRAL PART OF THE EFFICIENT TOOLROOM

Smart & Brown Model 'A' 4½" Centre Lathe . . .

Features include—large diameter hardened, ground and lapped nickel steel hollow spindle, two long parallel adjustable phosphor-bronze bearings with ball thrust end washer, twelve spindle speeds, swing over bed 9¼ in. dia.—length between centres 20 in. Full range of ancillary equipment available.

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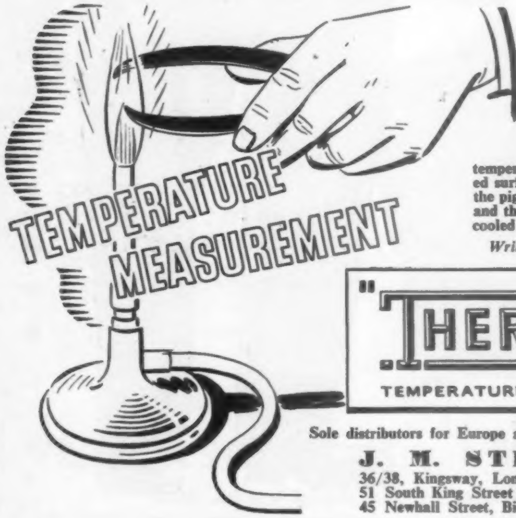

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They are supplied in the form of paints suitable for direct application by brushing or spraying to practically any surface and dry quickly at room temperature. When the temperature of the treated surface is then raised, the original colour of the pigment changes sharply at a definite point and the newcolour persists after the surface has cooled down.

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At the Machine Tool Exhibition
STAND 201
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INDEX TO ADVERTISEMENTS

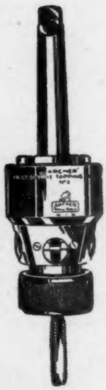
ARCHER

TAPPING ATTACHMENTS

with Auto-Reverse and Friction Drive

ARCHER SMALL-TOOLS

* Ask for List No. 105



"ARCHER" FRICTION DRIVE TAPPING CHUCK

For Tapping operations where the Auto-reverse is not required.

Top Jaws for positive drive on Tap Squares.

Lower Jaws for centering Tap Shank.

Both types made in three sizes up to ¾ in. Whit. capacity.

Eliminates Tap Breakages

"ARCHER" AUTO-REVERSE FRICTION DRIVE TAPPING ATTACHMENT

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ADJUSTABLE FRICTION DRIVE TO SUIT SIZE OF TAP AND MATERIALS

Special Features

Suitable for tapping either Open or Blind Holes.

Will work in Horizontal or Vertical position.

Standard Fitter's hand Taps are used.

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FRANK GUYLEE & SON LTD

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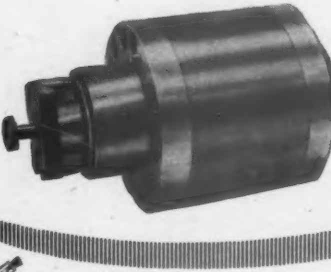
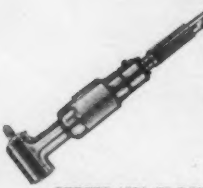
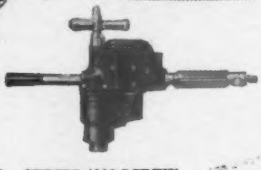
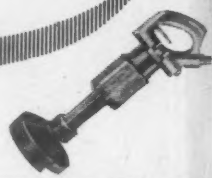
Completely self-contained, *interchangeable* motors make Holman Rotodrills and Rotogrinds exceptionally convenient and efficient in operation as well as unusually low in maintenance costs. Their power-weight ratio is appreciably higher than any other tools of equal capacity, and every tool in the range is a smooth-running, well-balanced machine with all the dependability associated with Holman Pneumatic Tools.



This self-contained power unit fits perfectly into every tool in the range, and is readily removed intact. Its cylinder walls are of hard chrome plate.







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SERIES 40 ROTOGRINDS—Useful range of general-purpose grinders, surface grinders, loco rod and extension grinders. Various speeds for all classes of work. Straight or grip handles supplied. Features similar to Series 4000 Rotodrills.

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